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The Structuring of Health Information System Options: Summary and Assessment of Methodology. Prepared as Appendix VII-A to the Final Report of the Health Information System Project.

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The MITRE Corporation provided technical support to the Joint Center for Urban Studies in its Health Information System Project by developing a structured approach for the characterization and analysis of System Options. The approach was designed to stimulate relevant dialog and aid decision processes in the technically diverse. politically sensitive. and multiorganizational Project environment. It contains an iterative sequence of analytical steps. beginning with the clarification of system objectives. embodying consideration of operating and computer support characteristics and their synthesis. and ending with the selection and planning of a preferred System Option. The approach assisted in the clarification and evaluation of alternative options. and aided Project leadership in guiding debate and converging on policy decisions. Such analytical aids may be useful in attacking a variety of social and urban problems. but the degree of formal rigor and the timing must be carefully tailored to each particular situation. (Author/TT)

THE STRUCTURING OF HEALTH INFORMATION SYSTEM OPTIONS: SUMMARY AND ASSESSMENT OF METHODOLOGY

Prepared as Appendix VII-A
to the Final Report of
The Health Information System Project,
Joint Center for Urban Studies of
The Massachusetts Institute of Technology
and Harvard University

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PREFACE

The interest of The MITRE Corporation in applying its systems analysis and design capabilities to address State and local community needs in the delivery of public services led to discussions with the Joint Center for Urban Studies (JCUS) regarding the Health Information System Project. As a result of these conversations, the two organizations saw the potential reinforcement obtainable by combining the two different kinds of experience which they represented. In view of the opportunities for mutual benefit, MITRE entered into a voluntary arrangement with the Joint Center for participation in the Health Information System Project.

This Project, being carried out by the Joint Center on a contract with the United States Public Health Service (Contract PH 110-234), had begun in August of 1967. MITRE began its collaborative effort one year later and worked with the Project during its last seven months. Operating in close cooperation with the Project management and staff, MITRE developed a structure for the characterization and analysis of system options, assisted in the application of the structure, and carried out a number of related studies.

This report is prepared as an Appendix to the Final Report of the Health Information System Project. Its purpose is to summarize and assess the structuring methodology which was developed during the collaborative effort. The report begins with a brief summary of the conclusions regarding possibilities for future use of the methodology within the next phases of the Project and for contributing to the solution of other community or urban system problems. This is followed by a characterization of the inter-organization and inter-disciplinary working environment of the Project. Next, the structuring methodology is described, and illustrated with supporting exhibits in the

form of tables or diagrams. Finally, an assessment is made of the apparent usefulness and limitations of the methodology within the Project environment.

We wish to acknowledge the leadership and guidance provided by the Project co-investigators, Daniel P. Moynihan and Victor W. Sidel. Mrs. Katharine G. Bauer, Project coordinator, provided extensive help during our orientation and valuable advice throughout the effort. Many useful insights on health information system problems were provided by Michael Joroff. Collaboration with John Rockart and Steven Lorch on system design and costing was also very helpful.

Finally, we would like to acknowledge the support provided by our colleagues in The MITRE Corporation and especially to recognize James H. Burrows and Eugene D. Lundberg for their direction and advice, and Alan J. Roberts for his many constructive suggestions regarding the content of this document.

ABSTRACT

On the basis of a voluntary cooperative arrangement, The MITRE Corporation provided technical support to the Joint Center for Urban Studies in its Health Information System Project. The major part of this effort involved, first, developing a structured approach for the characterization and analysis of System Options and, second, assisting in its application. Best described as "semi-systematic," the approach was designed to stimulate relevant dialogue and aid decision processes in the technically-diverse, politically-sensitive, and multi-organizational Project environment. The approach contained an iterative sequence of several analytical steps, beginning with the clarification of system objectives, embodying consideration of both "operating" and "computer support" characteristics and their synthesis, and ending with the selection and planning of a preferred System Option.

While its usefulness is difficult to assess fully, the approach assisted in the conception, clarification and more systematic characterization and evaluation of alternative options, and aided Project leadership in guiding debate and converging on policy decisions. Such semi-systematic analytical aids are useful in attacking a variety of problems in the urban and social areas, but the degree of formal rigor and the timing must be carefully tailored to each particular situation.

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SECTION I

SUMMARY OF CONCLUSIONS

The need in the Health Information System Project to generatc and evaluate system options, while operating within the complex political and other environmental constraints imposed by the Project, led to the development of a dialogue-aiding analytical framework to structure this work.

The major advantages of the approach are in assisting: (a) the conception and clarification of alternative options; (b) the more systematic characterization of the options and underlying issues after relevant debate about the critical factors affecting option feasibility and viability; (c) the evaluation of these options; and (d) the guidance of relevant debate by the Project leadership converging on the major policy decisions. The approach, however, cannot be indiscriminately applied, and must be tailored for each application. Systematic approaches in a politically-sensitive environment must be used with a great deal of discretion, the degree of formal rigor that is appropriate at any given time being the crucial factor.

In view of the recent trends to decentralize decision-making from the Federal to the State and local levels and in order to involve meaningfully larger groups or urban leadership in decision-making, a critical need exists for the development of more effective, semi-systematic aids designed to encourage relevant political dialogue. Improved decision-making aids can help to filter out extreme or heavily-biased comments and positions which unnecessarily polarize group reactions and attitudes, introducing negative and institutionally-biased reactions as opposed to creation of options more responsive to overall community problems.

The major difficulty of rigorous aids is that if developed too far or introduced at the wrong time, they could have railroading implications and/or a polarizing effect which subverts the very purpose for which they were intended.

It is recommended that further study be given to the development of improved, semi-systematic aids, using the experience acquired in the course of this study as relevant background for pragmatic research.

SECTION II

THE PROJECT ENVIRONMENT

The Health Information System Project served as a forum, bringing together a number of professional people of various disciplines as representatives of different organizations and agencies. These included both public and voluntary health or health-related departments or agencies for administration, planning and coordination, health service organizations, departments such as medicine, public health, sociology, political science, business, and city planning in several educational (and research) institutions, together with general social service and urban planning groups. Collectively they participated as members of the Advisory Committee and its subcommittees, or served as consultants, contractors or staff associates. Though on the one hand attracted to the Project because of a common interest – that of improving the delivery of health services to the community – on the other hand the group's viewpoints were as diverse as the organizational interests and objectives reflected by their representatives. While this diversity was necessary to the conception of a representative range of system options, the potential threat existed that it would prevent effective discussions of substantive issues necessary for the formulation and evaluation of the alternatives. This diversity also might have increased the likelihood of miscommunication, unnecessary prolonging of discussions, and difficulty in reaching agreement. Some of the possible major problems arising from the diverse objectives and backgrounds of the participants were:

1. the difficulty of communicating concepts because of the use of specialized terminologies within the interdisciplinary environment;

2. the underlying threat to agency privacy or confidentiality;

3. the implications of a new organizational arrangement on the existing power structure among the participating agencies; and

4. the difficulty of creating adequate incentives to encourage the sharing of data between those who generate it and those who need it for community-oriented planning and research.

The need to circumvent the problems related to these environmental constraints created the opportunity to develop a more systematic, yet politically acceptable, approach for assisting in the conception and evaluation of alternative organizational arrangements and computer-based information systems.

The major MITRE effort in support of the Joint Center was to assist in the structuring of alternative approaches or options for a Health Information System. Before the start of MITRE participation in the Project, three preliminary system options had been defined and characterized primarily in terms of the types of data processing capability involved. These options focused on a "directory" concept, a "file interface" processing concept, and a complete "management information system" concept (see Chapter VI of the JCUS Final Report). During the period of MITRE support, the Project formulated additional System Options, extended the characterization of the c ''ons into other aspects or dimensions (e.g., organizational implications, risks, costs, schedules), compared them, chose a preferred option, provided a more detailed and time-phased system description, a work plan, a project structure and cost estimates, and prepared a draft proposal to the Public Health Service.

SECTION III

DISCUSSION OF METHODOLOGY

OVERVIEW

In recognition of the Project complexities, a dialogue-aiding analytical framework was constructed. This framework provided a rational means for proceeding through the conception and evaluation of alternative options in such a way as to draw out relevant comments and ensure consideration of major factors and their relationships. This approach permitted the subsetting of the process by which Health Information System Options were generated, described and evaluated into an iterative sequence of basic activities or steps. At each step certain functional and organizational aspects were examined, introducing, as appropriate, discussions of technical, economic and operational feasibility. The major factors affecting the organizational arrangements were identified and their interrelationships discussed. Evaluation criteria for comparing system options were also derived. The insights obtained from this process then were used as a basis for formulating guidelines for the validation and evolutionary development of the selected option.

MAJOR STEPS IN THE METHODOLOGY

The overall approach developed to aid the systems structuring process consisted of the six sequential steps which are illustrated in Figure 1. These steps are briefly characterized below.

1. Clarification of System Objectives. On the basis of a review of the changing character and needs of the health community and the population served, the principal present barriers to the development and use of health information, and the scope

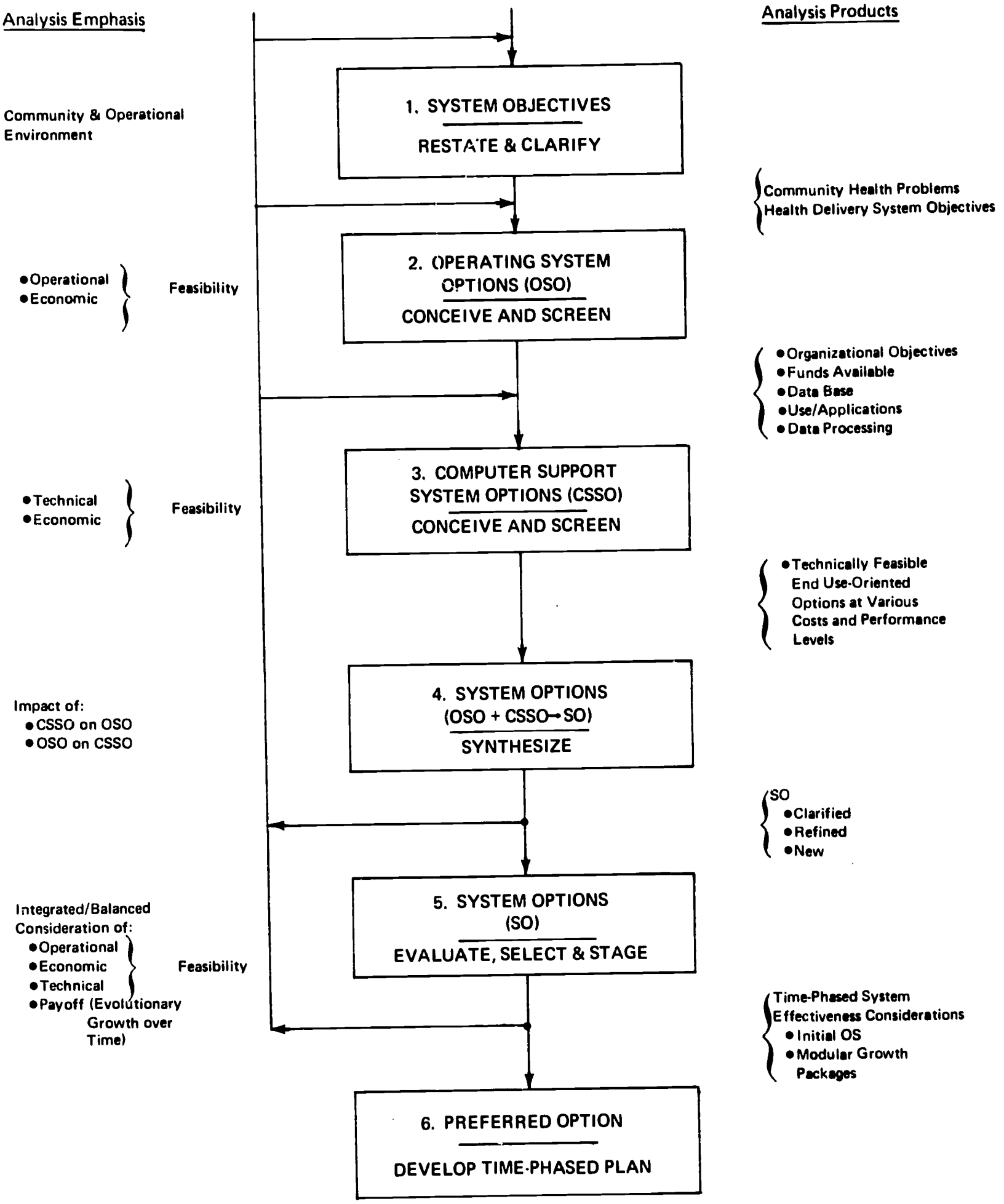

Figure 1. Structuring Methodology — Major Steps

of possible system applications, preliminary criteria for system functions and concepts of an evolutionary strategy were developed.

2. Conception and Screening of Operating System Options. Emphasizing considerations of organizational functions and structure and of operational and economic feasibility, this step involved generating, describing and comparing options in terms of system focus, functions and applications, organizational make-up, sources and character of data handled, privacy requirements, and source of funds.

3. Conception and Screening of Computer Support System Options. Dealing primarily with an analysis of the spectrum of simple to sophisticated data processing support capabilities and the range of previously considered simple-to-complex applications, this step emphasized questions of technical and economic feasibility. Tradeoffs of various performance levels, costs and time periods were identified and considered as a basis for the synthesis step which follows.

4. Synthesization of System Options. This step involved the analysis of the impact of Computer Support Option characteristics on Operating Option characteristics and vice versa. It required recycling through Steps 1, 2 or 3 as necessary to remove conflicts, or the generation of new system concepts to remove identified deficiencies. This process results in the definition of clarified and refined options combining operating and computer support elements.

5. Evaluation, Selection and Staging of System Options. The options developed in Step 4 were subjected to a comparative analysis of their overall operational, technical and economic feasibility, as well as their payoffs (i.e., total operational performance and scope) as functions of time. This analysis provided the basis for selection of a preferred System Option and for its "staging" in terms of an initial capability and for time-phased increments to this capability.

6. Development of a Time-Phased Plan. In this step, a work plan was developed for the selected System Option, providing further validation of its completeness and feasibility. This plan included additional characterization of the organization in respect to skill requirements of personnel and assignments of responsibility, and the definition of a specific objective, approach and general schedule for each subtask or element of the program.

In the conduct of the Project, the work defined by the above steps was performed in part sequentially and in part concurrently. Identification of the steps simplified and focused the preparation of material for working sessions.

This approach reflects the end product of many contributions made by individual participants. MITRE assisted primarily by providing the systems structuring framework; by proposing factors for delineation, screening and selection of options; and by preparing detailed material, especially relative to Steps 2 and 6.

CLARIFYING SYSTEM OBJECTIVES

The job of restating Project objectives was partly a vehicle for the establishment of a common set of concepts and vocabulary, and partly a vehicle for setting the ground rules for the subsequent generation of System Options and their analysis. A brief review was made of the major changes taking place in the health community, such as the rising cost of health services, the changing profiles of physician specialization, and the increasing awareness of the local community. Similarly, the principal present barriers to the effective generation and utilization of health information were identified – barriers arising from the fragmentation of data sources, the demands for privacy of information, the lack of data compatibility, and the often limited tools available for data processing and use. The potential

applications of the new system in the areas of planning, service, research and education were also related. Consideration of the changing health environment, of the barriers in the present information process, and of potential system applications led in turn to the development of preliminary criteria for selecting and evaluating system functions and to initial suggestions regarding the strategy of system evolution.

The results of this first step in the structuring process were documented in outline form only, and therefore could not be explicitly utilized in subsequent steps. In retrospect it appears that greater emphasis on this clarification process, and more definitive documentation of it, would have been beneficial.

CHARACTERIZATION OF OPERATING SYSTEM OPTIONS

In order to focus unambiguously on the functions which the system should perform, as well as on related organizational considerations, this step in the structuring process did not become involved with the data processing support which would be required. It emphasized the scope and focus of the system, its interfaces with the rest of the world, and what capabilities the system should have, not how these capabilities would be reflected in the character of needs for computer support.

On the basis of interviews with Project personnel, general reference to the restated system objectives, review of the three preliminary system concepts already defined, and consideration of the major elements that need definition in any information system, a set of illustrative operation-characterizing factors was developed and briefed to the Project Advisory Committee. This set of factors, eight in number, was designed as a check-off list to ensure that adequate delineation of the Operating System Options would be considered. Three factors are listed on the following pages.

1. Focus of System Objectives. These factors include the location and nature of the target population about which data would be collected; the relative emphasis given to information concerning the several phases of health service (prevention through rehabilitation); and the orientation in terms of addressing specific service problems and/or supporting specific health planning programs.

2. Roles and Functions of System. These are the scope and level of capability provided (directory service only through complete health management system): the degree of direct involvement of the system in the user's activities; and the character of the data management services provided.

3. Organizational Participation in System. This requires a specification of the organization or set of organizations to perform each of the three major roles in the system: system manager, system user, and source of input data.

4. Applications of System. This refers to the relative emphasis given the several user activities which the system is designed to support, i.e., planning, research, service and education.

5. Processes Generating Input Data. These include the relative dependence for inputs upon service operations, surveys of target population, legally required reporting, and health resource inventories; also the time characteristics (ad hoc to routine) of the collection process and the degree to which the specific purpose of the data collection can be defined.

6. Characteristics of Data. These include the types of data in the files (such as data on demography, disease prevalence, health service resources, use of services, payment and attitudes); and whether data on individuals or on aggregates only are stored and handled.

7. Requirements for Privacy of Data. These specify the character of restrictions on data acquisition or use, due to inherent data characteristics or to the nature of the using organizations, the intended type of use, and the type of data source.

8. Financial Considerations. These are types of expenses (development, capital and operations); sources of funds, particularly the balance between operating revenues obtained from system users; and support through grants or other awards.

The enunciation of the eight factors was completed at a time when the primary focus of Project effort was turning to the question of developing a more complete set of Operating System Options or alternatives. Drawing on the preliminary set of three options suggested earlier, and supplementing these with newly developed ideas on needed functions and applicational emphasis, the Project generated a set of six different Operating System Options or system alternatives to be described, compared and evaluated.

1. No System.

2. Directory and Information Service. This provides a catalogue of available health data files and services directed toward helping improve the files and assisting in their use.

3. Information Broker System for Health Planning. This system would provide information on available data and computer software files; work to improve and extend available data; conduct workshops and demonstrations on the nature and processing of health information; make computers available for users; and carry out related functions. The emphasis would be primarily or even wholly on utilizing data in aggregate form, rather than data on individuals.

4. Expansion of Existing Data System. Primarily this is a way of getting started, namely by building upon an existing information system such as the Blue Cross Data System.

5. On-Line Patient Data System for Clinical Support. Direct assistance is provided to the operations of service organizations such as hospitals through developing, and making readily available, clinically significant data on individual patients.

6. Comprehensive Computer-Based Information System. This provides, as a future goal, the capability to handle both aggregate and detailed information for planning, operating and managing the health delivery system and its associated functions.

For the purposes of the discussion in the next two subsections, it should be noted that the six options described above are not mutually exclusive; that options 1, 2, 3 or 5, 6 are in a rough sequence of increasing complexity; that 3 emphasizes the planning support, while 5 emphasizes clinical or service support; that 6 is a long-range goal rather than a system for near-term use; and, finally, that 4 is a way of starting which could be grafted onto 2, 3, 5 or 6. (Actually, the option finally chosen, although based primarily on 3, included 2, and also had elements of 6 and perhaps 5.)

This structure with its eight factors was used for describing the six Operating System Options, for helping to ensure that all relevant characteristics were considered, and for identifying major common elements and major differences. An example of the use of the structure is shown in Figure 2, which summarizes the major characteristics of one version of Option 2, the Directory and Information Service.

THE STRUCTURING OF COMPUTER SUPPORT SYSTEM OPTIONS

Using the basic contextual insight derived from the structuring of Operating System Options (see analysis products resulting from Step 2, Figure 1), a representative spectrum of simple-to-sophisticated computer support capabilities was identified and analyzed. Initially this step involved a categorization and description of representative computer capabilities in terms of their basic nature and characteristics (see Figure 3). Reading from left to right (i.e., "small" to "large") across the spectrum, specific

Key Description of Option: A Computerized Directory

1. Focus of System Objectives
   (a) geographical area – Boston SMSA
   (b) group of people – all the population in area
   (c) phases of health service – all (prevention through rehab.)
   (d) orientation – serving existing health programs

2. Roles and Functions of System
   (a) degree of processing capability – computerized directory only
   (b) degree of involvement . . . – reactive, routine data service
   (c) data management functions – identifying sources of existing data and helping to improve compatibility and standardization

3. Organizational Participation in System
   (a) management responsibility – commercial computer data service
   (b) users – primarily planning and research organizations
   (c) sources of input data – not a fixed list of organizations but includes public and private health or health-related departments and agencies, the Census Bureau, social service and urban/economic planners, etc.

4. Applications of System
   (a) planning and evaluation – all fields, e.g., for new facilities, systems of Medical care, etc.
   (b) service – may provide limited support for statistical reports
   (c) research – all fields, e.g., epidemiology, cost/benefit analysis, etc.
   (d) education – only training in information nature and use

5. Processes Generating Input Data
   (a) source data processes – service operations, surveys of population, legally required reporting, health resource inventories
   (b) purpose of data collection – mostly or entirely routine, repetitive collection

6. Characteristics of Data
   (a) categories of information – all (i.e., demography, disease prevalence, health service resources, use of services, payment and attitudes.)
   (b) degree of detail – index catalogue tells where to find aggregated data, and data on individual organizations. It does not provide indexes or data linkages regarding individual patients.

7. Requirements for Privacy of Data – no restrictions

8. Financial Considerations
   (a) system development and trial operation – expenses mainly cost of developing suitable sources of information, file structure, data management software; funding probably by grant
   (b) system operation – expenses mainly cost of small reference staff plus computer service; funding by revenue from users

Figure 2. Example of Operating System Option

			"SMALL" — "MEDIUM" — "LARGE"
BASIC NATURE			TIME-SHARED REAL-TIME ON-LINE NON-CONVERSATIONAL — SEMI-CONVERSATIONAL — CONVERSATIONAL BATCH – REMOTE BATCH – MULTIPROGRAMMED – ENQUIRY – DEDICATED TIME-SHARING – GENERAL TIME-SHARING – DISTRIBUTED DATA PROCESSING
CHARACTERISTICS	PERFORMANCE	RESPONSIVENESS	LOW (HOURS, DAYS) → HIGH (SECONDS, MINUTES)
		CAPACITY	SMALL STORAGE → LARGE STORAGE
		CAPABILITY	SPECIALIZED TO ONE JOB TYPE → EASILY TAILORED TO MANY JOB TYPES
		GROWTH FLEXIBILITY	NOT COMPATIBLE & FIXED CONFIGURATION → UPWARD COMPATIBLE & MODULAR GROWTH
	RISK		LOW (OFF THE SHELF) → HIGH (REQUIRING RESEARCH & DEVELOPMENT)
	TIME		SEVERAL MONTHS TO INSTALLATION → 5 - 10 YEARS
	DEVELOPMENT & INVESTMENT COST		$100,000 → $2,000,000 to $10,000,000

Figure 3. The Nature and Characteristics of the Computer Support Spectrum

System Options could be designed which would range from a batch-processing system to an extremely sophisticated general time-sharing system.

The batch-processing capability is representative of the simplest and most universal system organization which has been typical of computer installations until the last few years. The essential feature of this system is that one job at a time is run and the entire system is dedicated to that one job until it has been completed. The major drawback of this type of system is that batch-processing is inefficient in many circumstances, and the turn-around time (i.e., length of time between submission of a program and receipt of the output) is long, ranging from several hours to days.

At the other end of the spectrum, extremely comprehensive and complex software is being developed to enable many users at remote locations to have near-simultaneous interaction with a large computer facility capable of processing a wide variety of jobs. These jobs would range from simple file updating and retrieval to complex data search, statistical analysis and interactive (i.e., conversational) man-machine planning. This type of capability is known as a general time-sharing system and is exemplified by Project MAC of MIT. Distributed data processing, which makes use of a netted configuration of small to large computers, is adaptable to this basic general time-sharing system and has further advantages for some applications. These advantages lie in the use of the small computers and peripheral gear at remote terminals to handle the user's more trivial data processing requests, routing when necessary the more complex and time-consuming jobs to more powerful computers at nearby or distant locations. Thus the terminal can be used to efficiently perform batch-processing jobs (i.e., in a remote batch mode) or used for the more complex interactive man-machine planning, selecting the right type of computer capability from the various mode, configuration, and location options when needed. A variety of

peripheral gear at the terminal enables users with various skills and varieties of jobs to interact easily with the computer and/or set up jobs when the computer is down or unavailable.

The many variations between these two extreme capabilities (see Figure 3) can be broadly assessed by noting the different degree to which they possess the basic characteristics of responsiveness, capacity, capability, and a growth flexibility which are identified in the lower part of Figure 3. Against this spectrum an analysis was made of the computer support capabilities associated with the current health-related information systems which had been previously surveyed. *

The next step was to identify, categorize, and analyze a set of existing or possible applications, (i.e., problems amenable to computer support), derived from previous discussions and a health information system survey. The set of applications then was ordered to reflect the relative degree of complexity, and the type of primary use was indicated (i.e., service, planning research, and education). This spectrum of applications complexity is illustrated in Figure 4. Since the primary interest of the project was initially focused on planning and service applications, this was emphasized in the two illustrative sets of applications provided.

The first set of applications emphasized direct support to a specific service organization (e.g., hospital). In Figure 4, four types of applications with examples under each are arranged roughly in order of increasing complexity. Similarly, for a large community area such as the Boston SMSA, another set of applications was developed and is illustrated at the bottom of

*See Chapter II and Appendix IIA of the Final Report of the Health Information System Project, Joint Center for Urban Studies (JCUS) of the Massachusetts Institute of Technology and Harvard University.

EDUCATION	RESEARCH	PLANNING	SERVICE	TYPES & EXAMPLES OF APPLICATIONS
				I. SPECIFIC SERVICE ORGANIZATIONS (Direct Support to Operations)
X	X	XX	XXX	1. Routine, time periodic, clerical and administrative applications • billing • payroll • utilization review and services evaluation
X	X	X	XXX	2. Fast, distributed access for daily operations management • personnel, facilities equipment status (i.e., bed reservations system) • patient history and status (i.e., emergency ward patient data system) • screening and appointment scheduling and control
X	XX	X	XXX	3. Rapid or continuous monitoring and testing • automated laboratory services • critical patient monitoring
X	XX	XX	XXX	4. Integrated service facility operating management system (integrated support to 1 - 3 above at one or more locations)
				II. COMMUNITY AREA (Indirect Support to Operations)
X	XX	XXX	X	1. Analysis of slowly varying aggregate data • clearinghouse for health data services • agency and resource etc. data banks • simple epidemiologic studies
XX	XX	XX	X	2. Time-sensitive analysis and/or detailed medical data and/or record linkages • rapid, distributable access to specialized medical data (e.g., MEDLARS) • longitudinal patient and case register studies • interactive computer-aided instruction (CAI)
X	XX	XXX	X	3. Modeling, simulation and prediction • interactive problem formulation and solving • program impact simulation • simulated evaluation of alternative health delivery systems • inter-community/State models and simulation

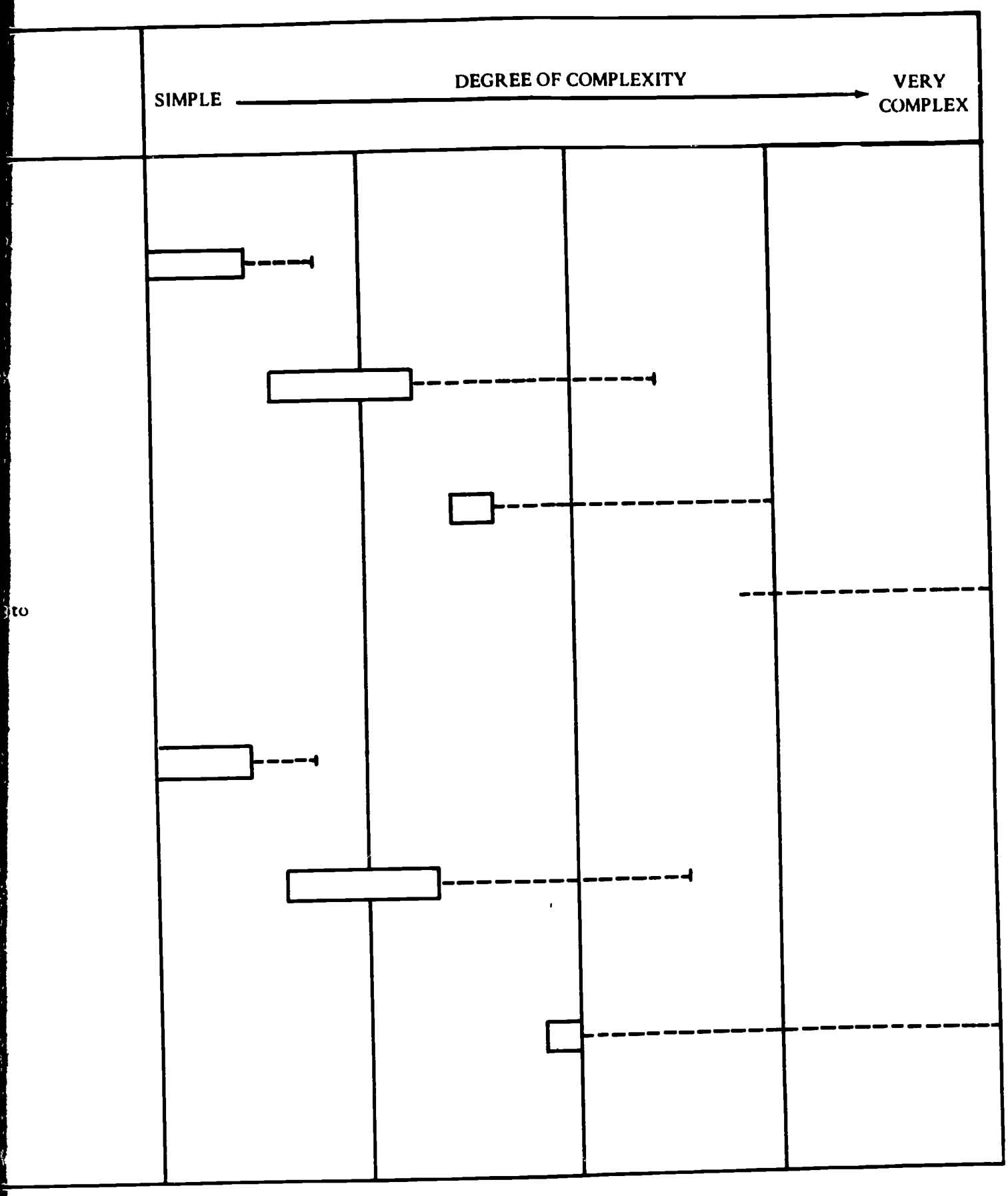

Figure 4. Types and Examples of Simple-to-Complex Health-Related Applications

Figure 4. As can be seen in the left-hand columns of the Figure, the first set of applications stresses service use while the second set stresses community-oriented planning use. Spillover benefits between categories of use also are indicated.

The right-hand side of the Figure indicates more explicitly the differences in degree of complexity and distinguishes between existing (solid line) and possible future (dotted line) applications. The degree of complexity was intuitively determined after considering the following factors. The problem/application is complex if

1. in response to a query, multiple files must not only be searched but rapidly updated to keep them current;
2. problem formulation is unstructured (e.g., hidden assumptions; vague decision rules; analysis in stages; judgment required to cope with intangibles);
3. considerable manipulation of a large volume of data is required.
4. the problem-solving process contains many variables, and data interrelationships are complex;
5. the job-processing requirement and/or man-machine interaction involved necessitates a rapid response time; and
6. distributed access from remote locations is required for data input and/or judgmental assessment.

To the extent that most of these factors are present, the application could become extremely complex, requiring sophisticated computer support beyond that now available.

This analysis of computer support sophistication and applications complexity permitted demonstration of several points. First, as computer configurations grow more complex in nature, they tend to reflect a greater degree of certain desirable characteristics: e.g., more directly usable in the delivery of health services, easier-to-use, more flexible and adaptable

to a wider variety of applications, and so forth*. However, the very complexity of such configurations tends to introduce additional technical (will it work?) and operational (will it be used?) risks. It also involves additional development time and a considerable increase in cost and in the use of scarce, skilled data-processing personnel.

Second, the basic computer support, e.g., data management and internal operating systems software, for more modest health information systems, i.e., "medium" complexity (see Figure 3) has been developed and is not only reliable but available at reasonable cost, ensuring lower technological and economic risk (the preferred Information Broker Option is in this domain). The basic computer support tools which will make technologically feasible the more comprehensive information systems needed for multifile, fast update service applications have yet to be developed. These, therefore, involve considerably more risk.

Third, though most major applications gravitate toward the use of more complex Computer Support System Options as the software support is developed, the simpler planning-oriented applications can more feasibly, from an operational point of view, make use of low-risk "medium" capabilities. On the other hand, more direct support of service-oriented applications, especially those operated on-line and having multiple-file, fast update requirements, tend to require the more sophisticated and hence riskier computer support capabilities.

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*A further development of this basic framework is reflected in Chapter VIII of the JCUS Report. This chapter discusses a set of more extensive characteristics/variables and describes their utility in terms of various types of health-related information systems.

SYNTHESIS OF SYSTEM OPTIONS

Having separately developed and analyzed a simple-to-complex spectrum of computer support capabilities and applications, the next step toward synthesis of a refined set of options was to combine the results of these analyses into an applications versus computer support spectrum framework as shown in Figure 5.

The purpose of this framework was to allow the visual mapping of operational System Options initially being considered. The map not only assisted in clarifying the differences among options but permitted relevant trade-off discussions to take place which could address differences in terms of

1) costs;
2) applicational purpose;
3) computer support requirements; and
4) the time to achieve an applicational payoff.

The major conclusion was that the Computer Support System Options required for the evolutionary and planning-oriented Information Broker Option were well within the technical state-of-the-art, (see dashed vertical line, Figure 5) and could be obtained at low risk and reasonable cost – this type of computer power being available at local university computational centers and/or service bureaus. In contrast, any substantial attempt to provide the more sophisticated computer support required to implement on-line, service-oriented applications would involve considerably larger startup costs, a longer payoff period and high risk. This conclusion weighed against any tendency to provide the latter type of support initially as a means of inducing the cooperation of service organizations in sharing their data bases with the planning agencies. In addition, the applications considered for the Information Broker Option were not overly complex (see dashed horizontal line,

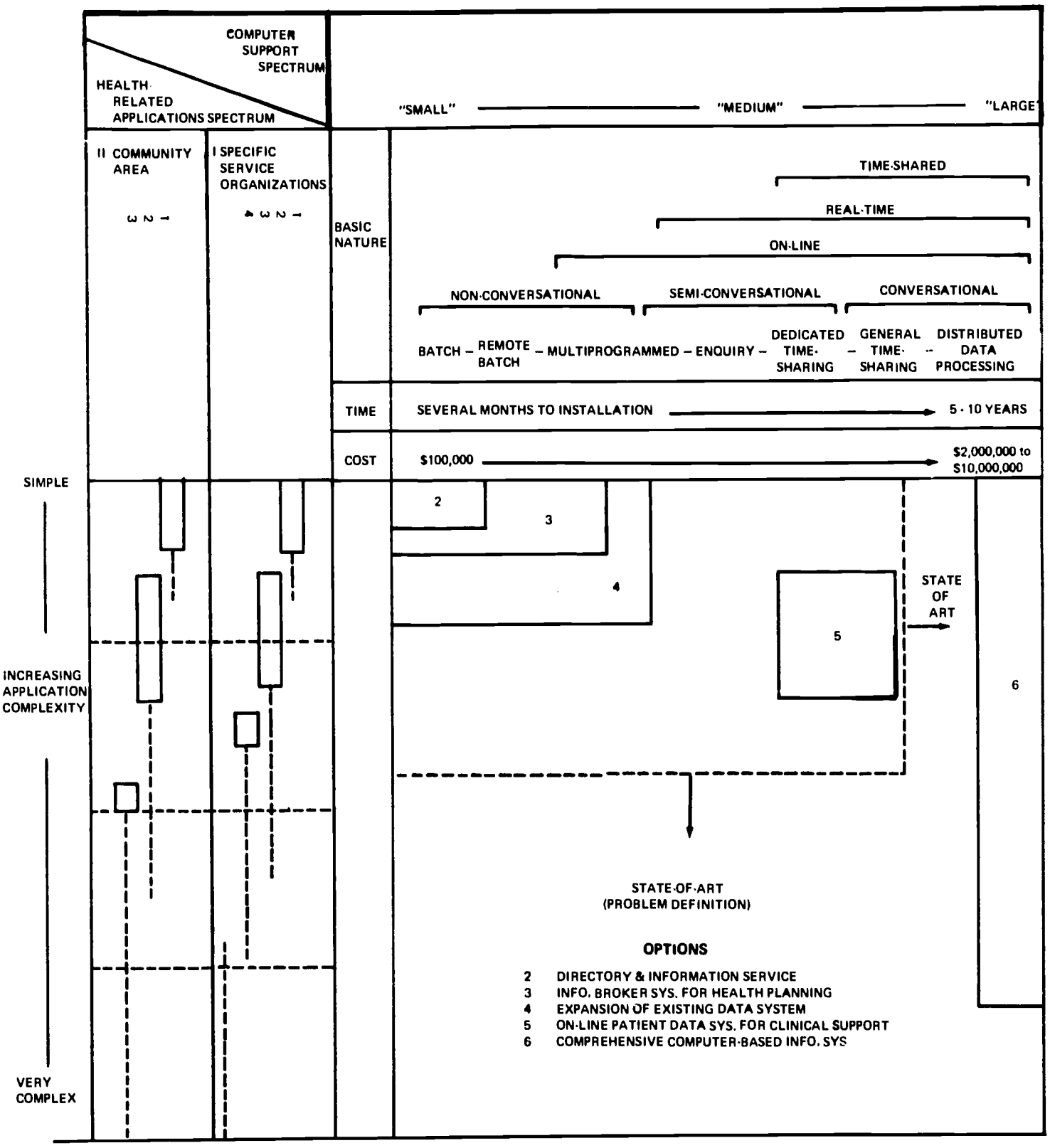

Figure 5. Computer Support versus Applications Map of System Options

Figure 5) yet urgently needed because of the current lack of a relevant structured data base for community-oriented planning.

The matching of Computer Support Options and Applications to the Operating System Options in this synthesis process aided in scaling down initial objectives of the Information Broker Option and influenced the system evaluation and formulation of the evolutionary development work plan (see the latter steps in Figure 1).

EVALUATION OF SYSTEM OPTIONS

Having dealt with options from the standpoints of operating characteristics, computer support characteristics, and the interaction between them, the Project could now address complete System Options and their evaluation. In this phase it was necessary to consider the overall systems in terms of functional performance, organizational characteristics, type of computer support, and system economics. In order to provide a basis for focused group discussions, the Project needed a means of comparing the options in broad terms which summarized the results of more detailed studies. The comparison shown in Table I furnished such an overall summary. This Table deals with factors, most of them generic to any systems analysis, which were believed to be most useful in sharply differentiating among options. For each factor used, the options were "rated" on a "scale" from small to large, or were defined by a simple descriptive phrase. In the case of costs, however, estimates of actual magnitudes were made.

The eight factors (most of them composite) pertaining to Operating Systems were reduced to four simpler ones: degree of processing capability (descriptive); size of data base (very small to very large); character and

Table I
Evaluation of System Options

Option Characteristics	2. Directory & Info. Service	3. Info. Broker Sys. for Planning	4. Expansion of Existing Sys.	5. On-Line Patient Data Sys.	6. Comprehensive Info. Sys.
OPERATING SYSTEM OPTIONS (OSO)					
Degree of Processing Capability (Beshers Options)	Index Catalogue	File Interface	Variation of File Interface	Special Purpose Management System	General Purpose File Interface and Management System
Size of Data Base	Very Small	Medium	Medium to Large	Medium	Very Large
Character and Detail of Data	Index Catalogue Only	Mostly Aggregated Data, Many Files	Transactional Data on Individual Patients	Critical Patient Data, Single Main File	Aggregated and Patient Data, Many Files
Privacy Requirements	Very Small	Small to Medium	Medium to Large	Large	Very Large
COMPUTER SUPPORT SYSTEM OPTIONS (CSSO)	a) Manual only or b) Small Batch Sys.	a) Small-to-Medium Batch Sys. or b) Remote Enquiry System	Determined By Choice of Existing Sys.	Medium, Dedicated, Time-Sharing System	Large, Flexible, Multi-purpose Time-Sharing System
SYSTEM OPTION (SO) EVALUATION					
PAYOFF — Magnitude of Assistance	Small	Medium	Medium	Medium	Large
PAYOFF — Applicational Coverage: Planners	†††	†††	††	†	†††
Service Org	†	†	†††	†††	†††
Researchers	††	††	††	†	†††
Educators	†	†	†	†	†††
Degree of Inovation	Small	Medium	Medium	Medium	Large
ORG ARR — Management Auspices Participants	Insensitive	New Corp, or "Neutral" Univ.	Existing System Manager	Set of Service Organizations	R&D Organization
STAGING — Stage I (Near Future)	Referral Service Plus . . .	Improved Access & Processing for Planners, Demos.	Determined By Choice of Existing System	Patient Data for Clinical Use	Tool Development and Demos.
STAGING — Stage II (Long-Range)	Indefinite	Plus Service Processing On Interactive System		Indefinite	Comprehensive Info. Sys. Capabilities
RISK — Operational	Small	Small to Medium	Medium	Large	Large
RISK — Technological	Small	Small to Medium	Medium	Medium	Large
COST — Operations (Cost per Month)	$8–20K*	$20–50K	$20–50K	$35–50K	$100–180K
COST — Development (Total Cost)	$50–100K	$100–500K	$100–500K	$100–250K	$2,000–10.000K

*If Computerized

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detail of data (descriptive); and magnitude of privacy requirements (very small to very large.) The nature of the Computer Support System was indicated by a simple descriptive phrase.

Six aspects of the overall system were used in the evaluation.

1. Payoff, i.e., operational performance and scope – total performance (small to large); relative distribution of applicational support among planners, service organizations, researchers and educators (small to large).

2. Degree of Innovation – (small to large).

3. Management Auspices and Participants – (descriptive comment).

4. Staging – character of near-term and of long-range configuration (descriptive phrase).

5. Risk – operational and technological (each small to large).

6. Cost* – developmental and operational (dollar estimates).

After reviewing summarized narrative descriptions of the options and discussing their relative merits, the Advisory Committee made decisions narrowing the range of possibilities. Over a period of time, the final option was delineated. This option (described in Chapter VII of the JCUS Report), was based primarily on the Information Broker System for Health Planning (Option 3) but included the Directory and Information Service (Option 2) and many of the elements of the Comprehensive Computer-Based Information System (Option 6) as a long-range evolutionary goal.

The information shown in Table I was utilized by the Advisory Committee in its discussions of the several options, but just how much it

*Cost data supplied by John Rockart.

helped the decision mechanism is difficult to say. It appears likely that the major determinants of the option selection process were the recognition by the Project that

a) an evolutionary approach initially using aggregate data could minimize the possibility of costly mistakes and avoid the privacy issue until the program had acquired form and stature;

b) a system that would be focused initially on support to planning would fill a relatively unique role and potentially would have a great deal of leverage; and

c) although the first phase of the system might be quite limited in objectives, the concept of the evolutionary program should give adequate scope for major future developments.

The presentation in Figure 5 and Table I facilitates the examination of the types of factors indicated in a), b) and c) above.

Finally, it should be noted that the evaluation approach developed in more detail, and with finer gradations in the measures used, would be an effective tool in a subsequent system design phase of the program.

DEVELOPMENT OF A TIME-PHASED PLAN

Although a preferred and generally feasible System Option had been chosen, several questions had not as yet been adequately answered. Could the functions identified for the system really be carried out within the operating constraints? Had any essential functions been omitted? Were the estimated costs sufficient to cover the work? These questions could best be addressed by developing the chosen option in considerably more detail, by structuring an organization, and by laying out a preliminary work plan. This detailing process was greatly aided by the insights developed through the earlier steps in the structuring methodology.

Major emphasis was given to studying the skills required to conduct the ongoing program, the various ways in which program responsibility could be partitioned, and the approach and schedule for each major task. Three major results were achieved through these studies.

1. The skills required in the people to be chosen for major roles in the program were described. This description highlighted the demands of the complex working environment, the need to accept guidance from many sources and yet exert leadership (often necessarily by indirect means), the need to become involved in helping the system user solve his problem, and the interdisciplinary character of the program.

2. A suggested allocation of program responsibility was made among the several involved parties, namely, the managing institutions, the project staff, policy or guidance committees, user and source data working groups, consultants, and computation centers or service bureaus. This was based primarily on making suitable tradeoffs between the desire, on the one hand, for a simple and direct chain of authority and the need, on the other hand, to recognize the political realities.

3. A preliminary work plan was devised for the various tasks involved in the first phase of the proposed program. The plan included a delineation of subtasks within each task; guidelines and suggested approaches; steps required for implementation; and definition of results and products.

An example of the last-named activity will serve to illustrate what was done. The listing in Table II shows candidate topics for inclusion in the joint Project/working group conferences, workshops, demonstrations, and follow-on processing services, which are important parts of the first phase of the program. The relevance of each topic to operational interests, economic interests, and technical interests is indicated. The list can be used to study the effects of varying activity levels, changing need or financial priorities, or shifting emphasis among the interest groups.

Table II

Conferences, Workshops, Demonstrations, and Follow-on Processing Services

POTENTIAL TOPICS	SUGGESTED EMPHASIS: OPERATIONAL	ECONOMIC	TECHNICAL
A. ORIENTATION AND TUTORIAL CONFERENCES			
• System Plan – Overview and Status	X	X	X
• SMSA – Community Problems and Other System Developments	X	X	
• Computer-based Information Systems	X	X	X
• Computer as Analysis Tool	X		
• Other Planning Analysis Tools	X		
• On-line User Languages	X	X	X
B. SPECIAL INTEREST WORKSHOPS AND SEMINARS			
• Compatibility and Standardization	X	X	X
• Source Automation Techniques	X	X	X
• Evaluation Criteria and Measures	X	X	
• Systems Analysis	X	X	
• On-line Planning Techniques	X	X	
• Health System Software Packages	X	X	X
• Planning Exercises	X		
• Privacy Issues	X		
C. COMPUTER DEMONSTRATIONS AND TRAINING			
• Source Automation	X	X	X
• Data Management	X	X	X
• Data Analysis	X	X	X
• On-line Planning	X	X	X
• Query and Programming Languages	X		X
• Privacy Devices and Techniques	X	X	X
D. ANALYSIS AND PROCESSING SERVICES			
• Data and Advice on Sources	X	X	
• Computer Broker Sercices	X	X	
• In-house Processing Support	X	X	
• In-house Report Generation and Dissemination	X	X	

As a result of the development and discussion of the more detailed program plan, a number of operationally or financially critical issues were highlighted for consideration and resolution. These included

a) what policy role the on-going Advisory Committee would have vis-a-vis the managing organization;

b) what tasks would be largely performed by the (unpaid) user/ data source working group instead of by the full-time staff; and

c) what fraction of the program resources and budget should be allocated to program evaluation instead of program planning and performance.

SECTION IV

OBSERVATIONS ON USEFULNESS OF APPROACH

The usefulness of the approach is difficult to assess in retrospect for several reasons. First of all, it was developed and implemented during the closing phase of the Project's activity at a time when formal and informal working relationships had largely jelled. In addition, a general feeling had already developed that a planning-oriented option of some type appeared attractive. However, other options or system goals, such as an on-line "Patient Data System" and a "Comprehensive Health Information System" which represented very different objectives, had also been proposed. The Computer Support System Options suitable to these various alternatives had not yet been debated. There remained the job of rationally comparing all the existing options, of extracting the most useful elements from each of them, and formulating a more suitable planning-oriented system option and implementing it.

Several other considerations restrict the assessment of this approach. For example, it was developed and partially tested in conjunction with a number of individuals, e.g., other staff associates and consultants, and partially used in working sessions and in the smaller Recommendations Committee prior to being briefed to the Advisory Committee. The latter Committee, in turn, tended to review and react to the products resulting from the analysis, e.g., evaluation of options and work plan, rather than be guided or constrained by the analysis process itself. (However, it did appear to be a useful aid to Committee leadership in guiding the discussions and in converging on the major policy decisions related to the selection of a specific option and the adoption of a next-phase work plan and proposal.) Thus the impact of applying this approach was fragmented among various

groups at various times. Nevertheless, some insights as to its use can be inferred from Project participation and from post mortem conference discussions with some of the participants.

First of all, it appeared useful as a basis for synthesizing and integrating the several efforts already completed. This exercise facilitated the synthesis of relevant, extractable material which had been previously developed in a form which helped to crystallize the various options. Participant feedback also indicated that the use of the factors suggested as a basis for characterizing Operating System Options was helpful in bringing forth relevant comments and debate. This permitted the detailing and characterization of specific planning options: e.g., differentiating between more conservative planning options and the broker option decided upon; in identifying substantive tasks associated with the broker option; and in the time-phasing of these tasks throughout a three-year development period as part of the required next-phase work plan.

Feedback also indicated that the aid was helpful in avoiding unnecessary or prolonged debate on some aspects of the politically-sensitive issues. Furthermore it served as an aid in presenting the issues surrounding and differentiating the various options and in arriving at group decisions significant to provide guidance for subsequent option refinement. Finally, it facilitated specific review and approval of a selected option and its associated work plan/proposal.

The approach could have been useful in more clearly identifying the specific Computer Support Option required but, in fact, was not so used. Responsibility for specifying the nature of this option tended to be delegated to a small group or delayed for future detailed design activity. The dominant interest at the time was in clarifying the organizational arrangement

necessary for structuring a viable organization needed to manage this next phase of effort. Perhaps the approach can be further developed and used at that time in conjunction with the computer resources evaluation framework and procedures developed in Chapter VIII of the JCUS Report.

A major pitfall in the use of "systematic" analysis approaches to policy and option formation in a politically-sensitive environment, such as the one described in this report, was almost experienced during one Committee session. It is worthwhile noting because it represents an instance of the limitations of "rational," quantitatively-oriented approaches in general. Though not a part of the procedure discussed in this report at one point in the Advisory Committee's deliberation over management auspices, a "principals versus principles" matrix was devised by some participants. The purpose of the matrix was to guide the more rigorous determination of organizational auspices during the next phase of development by scoring each candidate, i.e., principal, against various criteria, i.e., principles. Though this matrix initially appeared to be a useful idea, it can be conjectured that, had this been used, certain participants would have had to "objectively evaluate" one agency candidate versus another regarding such criteria as neutrality, cost, and so forth. Such evaluations probably would have been hotly debated (during or after the meeting) by the representative from the agency being evaluated as a "biased" judgment. The net result could have caused a polarization of various agency and organizational representatives, and deteriorated, to an unknown extent, the good will which the Project leadership had nurtured through informal discussions among the participants.

In short, rational analysis techniques introduced at the wrong time and alternatives quantified unnecessarily or with too great a precision could easily have subverted the major collective interests of the group. Fortunately,

in this instance, the pitfall was circumvented since the completion of the matrix was bypassed at the suggestion of participants who were thoroughly grounded in the pragmatic aspects of policy formulation.

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